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ABSTRACT

The patterns of use of computer-based communication technologies in knowledge synthesis are described by looking at the way groups use the technology for efforts that have at least some qualities of knowledge synthesis. A chart of basic options for communication through computers is provided, showing the generic class of systems, examples of specific systems, group size, form of communication, record keeping access to other resources, and complexity. Eight basic patterns of communication using computer systems are identified and discussed: (1) lots of interpersonal interaction, (2) emphasis on the group, (3) more interaction between users and producers, (4) a valuing of chance, (5) asynchronous communication and asynchronous thought, (6) divergence, (7) informality, and (8) technology as participant. Differences between these patterns and some of the more traditional approaches to knowledge synthesis are described. The paper concludes with some projections from these new behaviors of what the concepts of "knowledge" and "synthesis" may look like in the future. (CHC)

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KNOWLEDGE SYNTHESIS AND COMPUTER-BASED COMMUNICATION SYSTEMS: CHANGING BEHAVIORS AND CONCEPTS

by

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Paper prepared for

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KNOWLEDGE SYNTHESIS AND COMPUTER-BASED COMMUNICATIONS SYSTEMS: CHANGING BEHAVIORS AND CONCEPTS

One of the difficulties in assessing the impacts of any technology on a social or cultural process is that the process being assessed almost always turns out to be a moving target. It is not as though you could name all the pieces of furniture in a room, throw a magic technolgical switch, and then look for new additions to the collection. Rather, the technology seems to slither under the door and wrap itself around the various furnishings in the room, distorting them so that they **sort of** look like they did, say, 15 minutes ago, but not quite. And, of course, the names that you gave them don't quite fit any more, though you don't have any new names for them either. Furthermore, while you're trying to figure out what they should be called now, the very walls of the room begin to open up so that you can no longer tell what should be counted as part of the room and what should not.

This is the kind of problem we face when we try to describe the use of computer-based communication technologies in knowledge synthesis. We are tempted to start with a definition of knowledge synthesis and look for uses of computer-based systems that seem to fit within that definition. The problem is that the current concepts of both "knowledge" and "synthesis" are grounded primarily in the technological world of print media. There is no reason to assume that these concepts will remain the same or even particularly relevant in the technological world of computer-based communication. To look for examples of computer-based knowledge synthesis is thus something like looking for the kerosene in an electric light bulb--it may be possible to draw an analogy between the kerosene and the electric current but the analogy doesn't help much in understanding the potential of the electric lighting. . . or its impact on commercial signs, for example.

Still, computer-based communication systems are being designed and used for what is currently viewed as knowledge synthesis, and those who are designing and using such systems need to know which designs and which uses are likely to be effective. They also need to know how demands on them may change as the concept of knowledge synthesis changes in response to the new technology. In this paper, we will try to address

these questions, while maintaining an awareness that we are describing a moving target. We will start with the current patterns of use of computer-based systems--the way that we have seen groups use the technology for efforts that have at least some qualities of knowledge synthesis. We will suggest how these patterns differ from some of the more traditional approaches to knowledge synthesis. Finally, we will try to project from these new behaviors what the concepts of "knowledge" and "synthesis" might look like in the future.

BUT FIRST, THE TECHNOLOGY

Computer-based communication systems are proliferating. Furthermore, the distinctions between computer-based media and other electronic communications media are becoming increasingly blurred. Thus, before we start to examine new behaviors and concepts that may emerge with computer-based media, we need to clarify which media we are considering.

One way to clarify the class or classes of media that we want to consider is to explore some basic questions about the technology. For example:

What is the group size supported by the communication technology? The variety of available computer-based systems support a range of group sizes. Electronic mail systems typically support one-to-one communication: although the same message may be sent to a number of people, there is no "sense" of a group because no group is defined in the system. Computer conferencing systems, on the other hand, are explicitly group communication systems. The system defines activities in which there are members; all public messages in such activities are typically available to all members of the group. Videotex systems go still further; they begin to overlap with mass media since they are designed for a mass audience. They also use some of the same equipment as the most familiar mass medium--namely, the television screen. However, they retain the interactive quality of conferencing and mail systems. Of course, in the opposite extreme from videotex, there are computer information storage and retrieval systems that involve communication with a computer; and there are journal systems that support communication with oneself.

While all of these systems could have an impact on the practices of learning; experimentation, and application of new knowledge, this paper is focusing on media that stress interactive communication and that support one-to-one or small group communication; we are thus **most** interested in electronic mail and computer conferencing systems.

BASIC OPTIONS FOR COMMUNICATION THROUGH COMPUTERS

Generic Class of Systems	Examples of Specific Systems	Group Size	Form of Communication	Record Keeping	Access to Other Resources	Complexity
Journal Systems	Augment Spires*	Communication with oneself	Text	Personal file	Typically text editor, data bases	Assumes some computer knowledge
Electronic Mail	Ontyme Hermes Mailbox	Communication with other individuals	Text	Personal file	Not typical	Assumes some computer knowledge
Computer Conferencing	Planet Confer EIES** HUB	Communication within a group	Text	Transcripts of activities	May provide access to programs data bases, text, editor	Does not assume computer knowledge but requires new learning
Videotex	Prestel Telidon Viewtron The Source***	Communication with a mass audience	Primarily text	Storage and retrieval structure	Not typical	Does not assume computer knowledge, minimal learning
Graphics Systems	Integraph HUB	Communication within a group	Text and graphics (sometimes audio)	Graphic images	Varies	Varies

*Actually, very few systems are designed to serve only as journal systems. Many data-base systems or text editors could also be used as journals. Also, both Augment and Spires have many other functions beyond journals. Augment, in particular, can also be used for computer mail or some forms of computer conferencing.

**EIES is an acronym for Electronic Information Exchange System. This system can also function as a journal system or for electronic mail.

***Videotex systems could conceivably provide all the other functions on this chart as well, though most of the early systems have not yet developed extensive communications capabilities.

What form of communication does the technology support? Most computer-based communication systems are primarily text-based systems. Like print technologies, they rely on alphanumeric characters to get the message across. But here, too, definitions are not so simple.

Computer-based graphic communication, for instance, is just beginning to emerge. Until now, most communication in computer graphics has been between one person and the computer. New systems, however, will allow remotely located people to communicate with each other graphically--much the way they might if they were both in the same room, using a blackboard to exchange ideas.* The computer also extends the graphic communication capabilities of individuals by processing data and representing them in more complex graphic forms than a person working on a blackboard might be able to develop. Both multi-user and single-user systems that encourage the representation of knowledge in graphic form seem likely to have a particularly important role in future efforts at knowledge synthesis.

What is the record-keeping process for the technology? The form and permanence of records of communication are major dimensions characterizing any medium. The record-keeping procedures of computer-based communication systems vary from none to extensive. Electronic mail systems, for example, often do not have any record keeping built into them; computer conferencing systems typically maintain a permanent record of the "transcript" of each activity; systems that resemble data-base systems--such as videotex--emphasize the storage of information as their primary service; communication is focused on the stored information.

It is also worth noting the variations in the form of the stored records. The records in computer conferencing, for example, are chronological, although they can be reviewed in other ways, such as by author or keyword. In fact, a characteristic of computer-based systems is that their categorization systems can be tailored, to some extent, to the individual user. In general, the user of computer-based systems has considerable personal flexibility in defining his or her records of communication; personal electronic files, which interface with almost any computer-based system, invite customization of records. (Even electronic mail messages can be stored by individuals in this way.)

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*For example, Northern Telecom has introduced a system called "Integraph" that provides interactive graphic communication along with audio teleconferencing.

What resources are accessible through the technology? In addition to providing access to distant human resources, computer-based communication systems may also provide access to other computer resources, such as computer programs for simulation models or statistical analyses packages, text editors, and data bases. Different systems place a different emphasis on this type of resource: electronic mail systems, for example, rarely make specific provisions for the use of other computer resources, although the environment in which electronic mail systems are used typically supports use of these resources, particularly if the user has some computer skills. To date, videotex systems have been designed to provide access to computer resources, namely stored data, with human communications as a secondary resource. Current developmental work in computer conferencing is seeking to provide more flexible access to computer resources such as programs and text editors **in the context of group discussions.*** Finally, some cutting-edge graphic systems support a combination of computer-generated graphics and human communication.

How complex is the use of the technology? The various system designs assume different degrees of user familiarity with computers. Electronic mail systems were originally designed for people who worked with computers regularly, and these people are probably still their primary users. The same is true of journal systems. Designers of computer conferencing systems, however, have usually seen their user market as less technical and less willing to put up with the less-than-human idiosyncracies of languages; nevertheless, they expect users to be able to use an ordinary computer terminal to gain access to a network, and to learn at least a few basic commands. Videotex systems are expected to be the easiest to use: the terminal is simplified, and the choices open to the user are limited.

In this paper, we will be talking primarily about computer-based systems that (1) support the exchange of information among groups of people; (2) support text and sometimes graphical communication; (3) maintain and structure records of information that can be retrieved both by those who create them and by others; (4) provide access to other computer resources, preferably in the context of group communication, and (5) are usable by people who have no special training in the use of computers.

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*For a discussion of this potential, see Hubert Lipinski, Robert Plummer, and Kathleen Spangler Vian, "Interactive Group Modeling, Part I: Extending Group Communication Through Computers," Institute for the Future, Report R-44, 1979.

This kind of technology has been used in a broad range of applications that demonstrate new ways of communicating, of handling information, and of producing information products. Most of the applications described in this paper are illustrations of what might be called "conferences"; their topics range from issues in education to subjects in transportation, energy, government policy, and chemical technology. Each of them involve activities that are, in some way, related to knowledge synthesis, **bringing together diverse strains of existing knowledge in their topic area to create a new understanding.** Each of them also illustrates some fundamental patterns that could eventually lead to a new concept of knowledge synthesis.

SOME BASIC PATTERNS

When we look at the uses of computer-based systems to date, we find some basic patterns in the way people communicate, the way they handle information, the way they solve problems. Each of these patterns can be compared to traditional approaches of aggregating, interpreting, and applying knowledge from a variety of sources. They suggest some possible innovations in the process of knowledge synthesis.

For example:

Pattern 1: Lots of Interpersonal Interaction

Everything that happens in a computer conference involves interaction. Thus, if the computer conference is the main arena for a synthesis project, the process is likely to be more interactive than traditional processes of knowledge synthesis. This pattern leads to an interactive approach to information. People rely more and more on interaction among each other as the procedure for obtaining information; they rely less and less on a process of extracting it from traditional sources such as published books, journals, and data bases. In each of the cases, there are examples in which a participant asks, rather casually, whether another participant knows anything about a particular problem (which may not even be directly related to the task at hand); almost always, other participants respond either from their own experience or from a contact with someone they know. Both the inquiring member of the conference and the group as a whole are privy to this exchange.

A four-month conference within a private corporation illustrates this pattern well. The conference involved eight people from different divisions of the company: its purpose was to build a better understanding of the formulation and safety issues involved in a new chemical technology. Among the difficulties that led the group to try computer-based communication were the difficulty of staying up-to-date with the field (due to problems of access, over-secrecy, and vagueness of formal reports); the difficulty of getting information at the times when it was most needed; and the difficulties that arose when project people became so immersed in their own projects that it was difficult for them to track related developments. The participants in this conference took responsibility for keeping each other up-to-date and for providing immediate or nearly immediate access to information. A member of the international division, for example, described the status of the technology in Japan. At another point in the conference, one participant described a problem he had encountered in a safety testing procedure; a computer conference colleague from another division checked with one of his co-workers on his own project and reported some suggested solutions for the problem. As a by-product of this interaction, the person with the problem also learned of another person in the company with relevant expertise.

In this sense, the conference became a kind of electronic hallway-with-proverbial-water-fountain; the result was an extension of opportunities for casual information exchange, an extension of "the old boy's club," in which access to things of value--in this case, information--was obtained primarily through contacts, through a network.*

Projecting this pattern into a future in which computer conferencing is used extensively for synthesis-like activities, we anticipate that information will be perceived quite differently than at present. Underlying the current view of knowledge synthesis is a perception of knowledge as an accumulation of information, as "facts." Information, in the current view is fixed, concrete, something that exists independent of either the person who produced it or the person who might use it. It is divisible; it has parts

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*It is interesting to note that Peter Gerstberger and Thomas Allen have found that information seekers tend to go to the sources nearest them for help, rather than to the best sources. (See Peter Gerstberger and Thomas Allen, "Criteria Used by Research Development Engineers in the Selection of an Information Source," Journal of Applied Psychology, Vol. 52, No. 4, 1968, pp. 272-9.) In our work with computer conferencing, we have found this same pattern, except that the computer conference changes the perceptions of who is nearest; it alters the "intellectual architecture" of the office. (See Robert Johansen, Robert DeGrasse, Jr., and Thaddeus Wilson, Group Communication Through Computers, Volume 5: Effects on Working Patterns, Institute for the Future, Menlo Park, 1978.)

that can be separated and used individually. It is essentially additive: information added to information produces more information and more information generally means more complete knowledge. In short, information is an object that can be handled, altered, and used like any other object in the real world. Perhaps the only difference between it and other objects is that it cannot be discarded outright. All information must somehow be incorporated in any new information; if it does not fit, some account must be made for its exclusion.

It is worth noting that such a view of knowledge is very appropriate to a culture in which print is the primary means of communicating ideas and experiences. Print has the same quality of concreteness as the scientific fact. It is an object, made up of component parts that can be reduced or combined. And it is persistent. It stands in archives, demanding that account be taken of it.

Information in a computer conference is more ephemeral, softer, less independent. So in a world of computer technology, information may not be perceived as existing independent of the interaction process or of a problem being solved. Rather, it would be created with new and different significance for each problem or need. This creation of information is a group process; it emphasizes the exchange of information rather than its capture in categories that are generalized to many problem areas.*

This more interactive approach to information could be seen as adaptive for several reasons: First, it is a manageable response to the problem of information overload. Computers have a tremendous potential for generating, storing, and displaying **data.** If guided by a "capture" model of information storage and retrieval, computer information sytems will only continue to aggravate current problems of "keeping up with the field." The concept of keeping up with the field stresses an inherently passive approach to information: so long as researchers are preoccupied with finding out what others are saying or have said, they are not saying anything themselves. They are not creating. Their work is being defined only in terms of what others have done. They are responding rather than initiating, being cautious and well-grounded rather than taking intellectual risks. While knowledge synthesis can be done this way, it is not as likely to produce

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*These constrasting qualitites of information in print and computer-based media parallel the distinction made by Brenda Dervin between information as a "brick" and information as "mortar." See (Linda, can you supply the proper reference in these volumes?)

the "qualtitative leap" often associated with really significant syntheses. And uses of computer systems that promote this passive model might actually function as a harness that reduces personal risk by constraining one's thinking to minor variations on what has been thought before.

By contrast, an interaction- or exchange-oriented model would build on the concept of a network in which data flow naturally toward the problem to be solved, interpreted along the way by people who have some understanding of the problem and hence some clarity about the type of **information**--as opposed to **data**--that is needed to address the problem. The focus is not then on "keeping up with the field" but on providing enough information about the problem to enough different sources--human sources--of data so that they can participate in interpreting the data and **creating** the information base for the synthesis.

There are some potential problems with the interactive approach and its rather amorphous view of information. For example, there are bound to be some anxieties about the sytematic quality of the new brand of knowledge synthesis; after all, scholarship has always been defined in terms of systematic review of what has gone before. But this model of scholarship is grounded in a print-based culture, and for the reasons stated above, it simply may not be adequte for a culture of electronic media. Beyond the anxieties about sytematic review, there is likely to be a tendency toward more duplication of efforts. Finally, the approach to information and knowledge suggested by this emphasis on interaction may prove very dependent on individual personalities. The work on groups and social networks suggests that the flow of information is as dependent on informal social factors as on task-related expertise; there is no reason to assume that computer-based groups and networks will be different. Thus, the products of computer-based syntheses are likely to reflect the particular social and personality variables much more directly if networking is stressed in the process. . .an observation that is related to our next basic pattern.

Pattern 2: Emphasis on the "Group"

Computer conferencing is a unique blend of group and text-based communication. Typically, text-based communication has been either one-to-one communication or one-to-many communication. Group communication has been largely verbal communication. Computer conferencing is both, and the blend can be a little uncomfortable for those engaged in synthesis activities.

Technologies such as handwriting, typewriting, and printing have apparently encouraged a single-person approach to synthesis. This tendency is often explained by the so called "linearity" of these modes of communication. Whether or not linearity is the explanation, most people will express a preference for--or even argue the necessity of--working alone when it comes to the basic "pulling together" of information. Maxims like "too many cooks spoil the broth" or "a camel is a horse designed by a committee" illustrate the reluctance to engage in group syntheses: it is **inefficient.**

Users of computer conferencing don't automatically change their minds about this matter either. They consistently give high marks to the technology for activities like exchanging information and opinions and for general discussion of ideas, while resolving disagreements, which involves a blending of information and ideas into a harmonious whole, gets rather poor scores.* This attitude is not universal, however. For example, participants in a conference on individually guided education graded the medium as "fair" for resolving disagreements, compared to the scientists and engineers in some of the more technical conferences, who gave it less-than-satisfactory scores.** But even the scientists and engineers who were involved in a conference on the future of transportation were able, ultimately, to accomplish their objectives. The conference lasted 5-1/2 months and was sponsored by NASA. Nineteen participants used a computer conferencing system to critique and integrate draft sections of a report to make a series of recommendations concerning research and development for intercity air and ground transportation through the year 2000--a task that would be difficult in any medium.

The transportation group illustrates well the kind of pattern that is likely to dominate synthesis in computer-based systems. Because of the overwhelming presence of the "group," one might predict that the integration of information and development of new knowledge will be accompanied by more-than-usual attention to group process. And, in fact, analyses of the entries in the transportation conference showed that **substantive** entries totalled 23 percent of all entries, while **procedural** and **social** entries totaled 36 percent--half again as many as the substantive entries.***

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*Jacques Vallee, Robert Johansen, Hubert Lipinski, Kathleen Spangler, and Thaddeus Wilson, Group Communication Through Computers, Volume 4: Social, Managerial, and Economic Issues, Institute for the Future, Menlo Park, California, 1978, p. 116.

**Ibid., p. 117.

***Ibid, p. 35.

If users of computer conferencing eventually become comfortable with group work, then, we can probably expect group process to figure strongly in the concept of synthesis. Those doing synthesis will likely claim that "if the process isn't right, the product won't be either." Different groups may value different processes--those stressing equality or those stressing structure, for example--but they will all be very aware of process. Solutions to problems will also be viewed differently. Solutions will not be seen so much as rational paths to be identified and followed; rather, they will be seen **explicitly** as something that is negotiated through a social or even political process.

The emphasis on group process also has a potential dark side, namely the possibility of a "group think" syndrome. While computer-based systems may produce a proliferation of different views they may, in some cases, obscure divergent views. Compared to face-to-face discussion, communication via computer is characterized by restricted channels of communication. In particular, nonverbal messages about cultural background, organizational commitment, and goals and objectives may be less perceptible. These missing cues may give the group a false sense of consensus or--at the other extreme--exaggerate stereotypes of issues. The syntheses that result from such a process could be not only ineffective but dangerous.

One of the key issues in structuring computer-based groups will be the membership: Who participates? As we noted with pattern 1, personalities are likely to play an increasing importance in the synthesis process if synthesis becomes more interaction oriented. In regard to "group think," divergent group membership would certainly be helpful while too homogeneous a membership could create problems. Careful attention to the list of participants could thus help avoid these problems and even solve one of the basic problems with the current practice of knowledge synthesis, as pattern 3 will illustrate.

Pattern 3: Users With Producers

With the current view of information as an object existing "out there," there has developed a basic distinction between "producers," who produce information, and users, who apply it. There's something akin to a class struggle here, with each class generally feeling a little self-righteous. The producers of information are most often guided by their understanding of the current "state of knowledge"; they judge themselves successful when their work advances the state of knowledge. The users, on the other hand, are typically guided by a specific problem; they judge themselves successful

when they are able to bring information to bear on a specific problem. Obviously, neither group will completely appreciate the efforts of the other, and in fact, their failure to communicate is one of the key problems cited in many areas of research--especially in education. The distinction between the two groups may shift from situation to situation, but most people will know clearly when they are functioning in each role--and their expectations of the "information" will vary accordingly.

With computer-based systems and a more dynamic concept of information, we might expect a blending of roles of users and producers of information, since those who produce the information will be interacting more directly with the users and more directly with the specific problem. Users and producers will be more likely to generate information jointly, rather than one for the other. Also, given the ease with which computer networks cross institutional and geographic boundaries, computer-based communication systems may also bridge some of the institutional divisions between those who are practitioners and those who are attempting to provide a knowledge base for improving the practice.

For example, a series of conferences has been held using a system known as Legitech.* These conferences typically involved both legislators and policy analysts in exchanges that varied from broad explorations of alternative approaches to solid waste disposal to discussions of specific legislative restrictions in purchasing procedures. These conferences offered an alternative to the traditional approach in which policy analysts, commissioned perhaps by some government agency, would go off, analyze an issue, and then present their results to the group. In the Legitech system, anyone involved in the conference could ask a question, using a specific format; those who were interested could go to another level of the conference to get a more detailed explanation of the question, and then to still another level to view responses or respond themselves. Thus, the criteria that brought people together to discuss a specific subject were not institutional affiliations or job descriptions, but interest and competence in the specific questions being addressed. In such a process, roles become less clear, and it is difficult to discern who is producing information for whom. The information simply "grows" in response to a specific question.

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*Chandler Harrison Stevens, "Many-to-Many Communication Through Inquiry Networking," World Future Society Bulletin, November/December 1980, pp. 31-35.

Beyond the breakdown of the conceptual barrier between users and producers of information is the potential for those engaged in research to take more responsibility for the way that knowledge is applied. Conversely, practioners in this kind of interaction take more responsibility for the way that research problems are defined and information is generated. These are both practical and moral requirements in today's world. The pattern of blending the roles of information user and information producer speaks directly to these requirements.

Pattern 4: A Valuing of "Chance"

Gordon Thompson, after a historical review of previous communications innovations, concludes that one of three primary characteristics of a communication revolution is that it has "increased the ease with which shared feelings could be discovered and developed in the host society."* Such "chance" encounters to develop new contacts and possibilities can easily be enhanced by computer-based communication systems. Users can use the system as an "electronic sidewalk" (Thompson's term) to stroll along and make new acquaintances, whether they be across town or on the other side of the world. Computer capabilities for storing broad ranges of information and drawing associations by various criteria (including random matches) also add to the potentials for chance encounters. Such capabilities might be employed to bridge differences among diverse audiences who rarely have the opportunity for direct contact (for example, academics and lay people).

One example of the use of computer conferencing to expand chance encounters of ideas is provided by a company that users the system to support a kind of knowledge synthesis activity among its staff. This activity involves a computer conference that has only a very general topic and no specific goals other than to serve as a forum for ideas related to the general topic. Participants are encouraged to invite others to participate--others who may have some interesting perspectives. No attempt is made to control the direction of the conference or list of participants.

In general, the computer conference creates an atmosphere of chance. Because it is asynchronous--that is, people come and go according to their own schedules rather than all being "online" at the same time--participants never know exactly what to expect

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*Gordon B. Thompson, "An Assessment Methodology for Evaluating Communications Innovations," IEEE Transactions on Communications, Vol. COM-23, No. 10, October 1975, p. 1048.

when they enter the conference. There may be no new messages or 50 new messages. The discussion may have taken a new and entirley unexpected turn. They may be entirely alone in the conference (this usually the case), or they may be pleasantly surprised to see a colleague from across the country log on just as they are reviewing the transcript from the previous two days.

As people become more comfortable with this lack of control and structure; as they, in fact, begin to enjoy the serendipity of computer conferencing; they may grow to value chance in all of their work. In the case of knowledge synthesis, such an emphasis on chance would be likely to mean a much broader base of knowledge being synthesized, plus more creativity in the process since more divergent strains would be brought together.

It should be noted, however, that computer-based systems could also be used to increase specialization and narrow the range of one's contacts. Reading an electronic newspaper, for example, could encourage readers to look for those "stories" they already know they want. They could be encouraged to look only at stories in a narrow range of topics rather than browsing, as in reading the pages of a conventional newspaper. It would perhaps be most accurate to say that computers increase the range of options for both increased specialization and exposure to a wide range of change meetings. Also, assuming that the virtues of chance syntheses are acknowledged and encouraged, another potential problem could arise: chance encounters could be emphasized at the expense of more intentional activities. If this should occur, the user would obviously have less control over synthesis and probably have less success as well.

Pattern 5: Asynchronous Communication, Asynchronous Thought

Another product of the asynchronous nature of computer-based communication is the potential for calmer, more reflective thought **by a group of people.** The environments in which knowledge synthesis currently takes place are often hectic environments. The activities of the day are driven by interruptions--rining telephones, visitors, crisis to resolve. Furthermore, when interacting in a group, people are usually under pressure to respond immediately. They are reluctant to take group time to examine a detail about which they, personally, may need more information. They are often reluctant to say: "Let me think about it."

In computer-based communication they don't have to say it. Such systems are typically used asynchronously: each person checks for new messages according to a

personal schedule, makes new entries, and leaves. There is no requirement for simultaneous communication, as with face-to-face meetings on the telephone. This self-activated quality, present in many forms of computer-based communication, could open the way for more conscious use of private reflection time as part of the synthesis process.

In actual uses of computer conferencing this potential is realized in different ways. It may be as simple as the use of a series of private messages to provide bibliographic data for someone who mentions a problem. Or it may be a series of exchanges in which an outside resource is consulted. Often someone will mention an idea from a book in the context of a conference. A second person, intrigued by the reference, will look it up, think about it, and return to the conference with a new commentary. The person who originally referenced the book may then find it necessary to reread portions of the book before responding. The dialogue that results could never have happened face-to-face.

It is obvious that synthesis requires reflection time; personal insight is often at least as important as systematic search procedures. This sort of intellectual effort requires personal discipline, careful preparation, and time. It is not done mechanically.

Of course, not everyone will experience computer-based communication as low-demand communication. For instance, what is "low demand" for one person may be "on call" for another. Rural telemedicine experiments have demonstrated this point clearly; a system that provides new links for a rural area may provide new burdens for a central hospital. In the case of knowledge synthesis, the situation is different but with key similarities. External constraints or the desires of others working on the synthesis may make it difficult for each person to have full control over his or her own thinking sequences. The new technologies introduce new opportunities, but also new complications.

Finally, a possible problem with the asynchronous thought pattern is the possibility of placing inordinate emphasis on the personal thought process. Raising personal inspiration to a mystical pedestal could provide an easy excuse for avoidance of the more routine--but important--aspects of the knowledge synthesis process.

Pattern 6: Divergence

Knowledge synthesis--or any synthesis--evokes the image of bringing together many diverse elements into a single whole that is somehow "larger than the sum of its parts." It is a process that starts out divergent and then converges.

Convergence is often hard to obtain in computer-based group communication. Systems that support such communication are typically seen as useful for brainstorming and generating new ideas--divergent processes--but inefficient for activities that require convergence. For example, a very successful computer conference in the area of education was the one mentioned earlier that addressed the topic of individually guided education. This was a four-month conference, sponsored by the Kettering Foundation, to facilitate the exchange of ideas and plans among eleven educational consultants working in the field of individually guided education. These participants were located across the country in areas where they had little intellectual support and few resources, yet they were actively involved in designing programs. The computer conference provided a meeting ground for developing an understanding of the "state-of-the-art." Yet the statement of the state-of-the-art was not its purpcse. Thus, it could continue to diverge up to the final messages--and it did.

This emphasis on divergence is well suited to an operating environment that appears increasingly complex. More and more, social analysts are suggesting that the "problem-solution" model of research is inadequate. Social processes are seen as "messes" rather than well-defined problems; in this situation, what is needed are processes that generate multiple variables and multiple relationships among those variables.

Also, in this situation, problem-solving requires a multidisciplinary approach, an evolving approach. The problems of such approaches lie primarily in the difficulty of communicating--of conceptuatlizing the immediate issue--when people hold different rigid, precise concepts from their own disciplinary perspectives. A more fluid conceptualization process could help to reduce this communication barrier. And divergent processes, in which each person has access to a broad range of inputs but no group statement is required, may be just the kind of fluid process. It may encourage an informal approach to knowledge synthesis, as pattern 7 suggests.

Pattern 7: Informality

Inherent in the notion of knowledge synthesis has been the expectation of continuing transformation of concepts. In practice, however, syntheses--particularly very good syntheses--become barriers to continuing development of ideas. They take on an authority that resists change, a resistance that, ultimately encourages a reformulation, a

new paradigm.* This process, however, is a pattern grounded in a print-based culture. As we have suggested, information in this culture is a collection of facts, of independent objects. Because it is, it can be classified. It can be classified by disciplines, fields, and subjects. In can be classified by library classification schemes. It can be classified by its similarities with and differences from other "units" of information. And the classifications can become very fine.

This classification process, besides involving people in the task of actively analyzing the information to classify it, produces other behaviors. It tends to encourage communication along the lines of classifications; that is, within disciplines, fields, and subjects, rather than across them. It also tends to encourage knowledge to develop within these classifications, rather than independent of them. It encourages people to look in one pigeon-hole, ignoring the rest, when they are pulling together information for a synthesis.

In short, the concept of information-as-fact leads to a formal approach to knowledge with formal problem statements, formal classes of data relevant to the problem, and formal syntheses, formally stated. By contrast, communication in computer-based systems is almost always less formal and less concerned with form than print-based media. Hence, it is not surprising that concepts themselves might become less formal with less emphasis on their being complete, authoritative "packages."

This informality could have a number of impacts on the way that people do knowledge syntheses. For example, as we have already suggested, there might be no expectation of the "final word" on a topic; in fact, topics themselves are likely to become much less clearly defined in a world of electronic knowledge synthesis. The emphasis in computer-based communication on increased interaction and the breakdown of distinctions between users and producers of information, together with the informality of that medium, suggests that disciplinary boundaries may become less stable; that fields may intermingle. Categories and categorization systems would be less static and more dynamic. The goal to develop concepts that are encompassing, while simple and precise, may be replaced by a goal to develop concepts that are sufficiently ambiguous to provoke creative, novel thinking--to continuously reshape the concepts.

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*This, of course, is the picture of science painted by Thomas Kuhn, The Structure of Scientific Revolutions, Chicago: University of Chicago Press, 1962.

This more dynamic process of conceptualization may eventually be perceived as more trustworthy than traditional syntheses precisely because it is less formal. With the still-growing number of journals and books and newsletters, formal "packages" are likely to lose some of their credibility. They certainly must compete continuously among themselves, and such competition often leads to an emphasis on packaging more than on substance. A less formal, more dynamic approach to conceptualization would force attention toward the concept itself, and hence be viewed as more "honest."

Finally, the informality of computer-based communication creates an environment conducive to more intellectual risk-taking. Because the knowledge synthesis process is informal and does not demand precision, new ideas and new formulations can emerge more rapidly and be tested in the field more readily.

Pattern 8: Technology as Participant

Communications media are often seen as more or less invisible; they are channels of communication but not participants in the communication process. While this view can be questioned for all media, it is particularly questionable in the case of computer-based communication systems. Such systems generally combine a communication channel with specific computer capabilities. Thus, users of such systems may interact with the computer **in the context of group communication;** in this situation, the system takes on some of the qualities of a participant in the communication process.

As a participant, a system may not only provide information--such as data from a variety of data bases or answers from the execution of a problem-solving program--it may also structure the communication in a variety of ways. Management information systems, for example, often require communication in set forms that are standardized across an organization; while designed primarily for administrative purposes, such systems may find their way into the world of research, particularly in the private sector. Thus, categories and forms of communication designed for purposes other than research may ultimately influence the practice of research. Some systems may also be designed specifically to structure the research process. The HUB system, a prototype system at the Institute for the Future, is an example.* This system encourages users to communicate "through" computer programs; comments are stored and displayed with various

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*See Lipinski, Plummer, and Vian, op cit.

program runs to which they refer. Such systems may have the effect of reformulating or reframing a concept. Furthermore, a computer-based communication system may be programmed to moderate the communication patterns in particular ways: to collect certain information from all participants, for example, or to monitor participation and prod those whose participatin is low while restraining those who are dominating the process.

While the actions of the technology will reflect the goals and values of the users--the balancing of participation, for example, reflects the value placed on equality--the technolcgy itself will contribute to the understanding of data in ways that may not be recognized or even recognizable. Computer graphic systems are perhaps the most striking example. Such systems are being used increasingly to help people visualize processes that are very complex and difficult to describe or understand verbally. These sytsems need not present only one visualization; the computer can conjure up 100 different visualizations as easily as one. The intellectual concepts that proceed from these various visualizations might thus be more like probes or triggers than comprehensive accounts of the process under study, supporting the dynamic, informal conceptualizations described in pattern 7.

Computer graphics may affect the synthesis process in another way, too. It may provide people with a more direct **experience** of information. A visual representation of numerical data is often assimilated more rapidly than are the numbers themselves because they are experienced rather than analyzed. These experienced understandings also often carry more credibility than a verbal description or analysis because people tend to define as "real" things that they can experience directly. Nevertheless, the technology itself is contributing to the experience: the CRT on which the visual image is displayed has certain characteristics that allow certain experiences of the data and not others--just as the human physiology allows certain experiences of sensory data and not others. The computer's capability to extend the experiences does not make it less subjective. It simply offers a new kind of subjectivity. In this sense, the computer represents an alien intelligence.

One of the problems that is likely to arise with this pattern of the technology as an active participant in the knowledge synthesis process is the question of responsibility. If the technology assumes a more active role, it may also come to be seen as responsible for the outcomes, relieving humans of this responsibility. At one level,

this tendency can be expected to foster the expectation that technological systems are the solution to social problems. At a more subtle and possibly more dangerous level, this assignment of responsibility to the technology may lead to a feeling of intellectual impotence. In any case, it seems likely that users of computer-based systems will anthropomorphize the computer and invite it into their discussions. Examples of this behavior already exist; the following message appeared in the conference on individually guided education:

> Checking in at 7:55 a.m., C.S.T. shows no new entries since I last talked to "Jennie" . . . by the way, if I am going to swear at something, it has to have a name . . . so this thing has been named Jennie!

COMPUTER-BASED KNOWLEDGE SYNTHESIS: SOME NEW CONCEPTS

The patterns of communication that we have observed in computer-based communication suggest some new approaches to the activity we now call knowledge synthesis. They suggest that this activity will be an interactive one in which information is created for specific needs. This information does not pre-exist, but evolves as participants in the synthesis process jointly interpret the existing situation. Users of information will be simultaneoulsy producers of information and vice versa. Together, they will stretch their common understanding in several directions until a new understanding emerges. The emphasis in this process will be on group interaction more than on efficiency of the process; hence, there will be a high awareness of group process. The understanding that emerges from this process will not be the "final word" on the subject, but rather an "opening"; continuous transformation of concepts will be a conscious goal. Thinking will be more divergent and less formal. And it will be more obviously and deliberately a response to the communication technology itself.

Such an activity may barely resemble knowledge synthesis as it is practiced today. And in fact, the very concepts of "knowledge" and "synthesis" are likely to be different. Knowledge, growing out of this kind of process, will be less objective. It will be more closely tied to feelings, the shared feelings of a group of people. This emphasis on feelings follows from the interactive, informal nature of knowledge synthesis activity; from the linking of knowledge "products" to group process; and from the tendency to **experience** knowledge through the technology, through situations--or simulations--created by the technology.

"Synthesis" will also carry a different meaning in the world of electronic group communication. With a less objective, more subjective concept of knowledge, synthesis will not be so much a pulling together of information and transformation of concepts as the active creation of shared experiences for the group. In other words, when a group sets out to do a synthesis, their intention will be to **synthesize** an experience out of which some new group understanding will emerge.

In the future, the concept of knowledge synthesis, as the authors in these two volumes have been discussing it, may fade away. In its place will be a new concept, a new kind of activity. We might best call this activity "synthesized experience." At this point we can only begin to imagine the nature and impact of such an activity.